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AN EVALUATION OF A HIGH PRODUCTION INTEGRAL SPRAY PATCHER

MATERIALS INFORMATION
ENGINEERING MATERIALS OFFICE

AN EVALUATION OF A HIGH PRODUCTION INTEGRAL SPRAY PATCHER

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Abstract

Selective spray patching with a conventional surface treatment train (ie. distributer, aggregate spreader and rollers) is cumbersome and inefficient. Changing patch width involves stopping the work, adjusting the spray bar, recalibrating the binder application rate and adjusting the gates on the aggregate spreader.

Ontario Ministry of Transportation and Communications staff observed a machin in Sweden which could change patch width on the go and at will. The machine, the Dynapac Pavement Patcher, sprays emulsion, spreads aggregate and compacts the patch all in one pass. It was felt that this machine could: reduce the labour requirements for patching roads; improve the riding quality of these roads; and provide a viable pavement repair alternative.

The MTC Highway Operations and Maintenance Division, in conjunction with the Bituminous Section, arranged to demonstrate this machine on provincial highways during the summer of 1985. This paper details the Ministry's experience to date with this equipment including costs, construction techniques and initial patch performance.

1.0 Introduction

In the summer of 1985, the Ontario Ministry of Transportation and Communications organized a full-scale demonstration project with the Dynapac Pavement Patcher HR-21. This was the North American debut of this machine. The purpose of the project was to establish costs for mechanized spray patching and evaluate its capability and performance.

The Dynapac Pavement Patcher is a highly mobile spray patching unit which is capable of spraying emulsion, spreading aggregate and compacting all in one pass. It is capable of varying patch length and width on the run to match pavement defects.

Three hot mix pavements and two surface treated pavements, located in Southern and Central Ontario, were selected for treatment. Pavement defects treated include segregation, pavement edge breakup and centreline, edge and alligator cracking.

The binder used in the work was a rapid-setting emulsified asphalt in combination with washed chips. An additional trial was conducted utilizing the machine for full width surface treatment using a high float emulsion and crusher run material.

This paper details the Ministry's experience to date with this equipment. Included is a discussion of; equipment and materials, construction techniques, costs, pavement types suitable for repair, performance of work to date, comparison with traditional spray patching methods, conclusions and recommendations.

Figure 1 : Hwy. 46 Before Repair

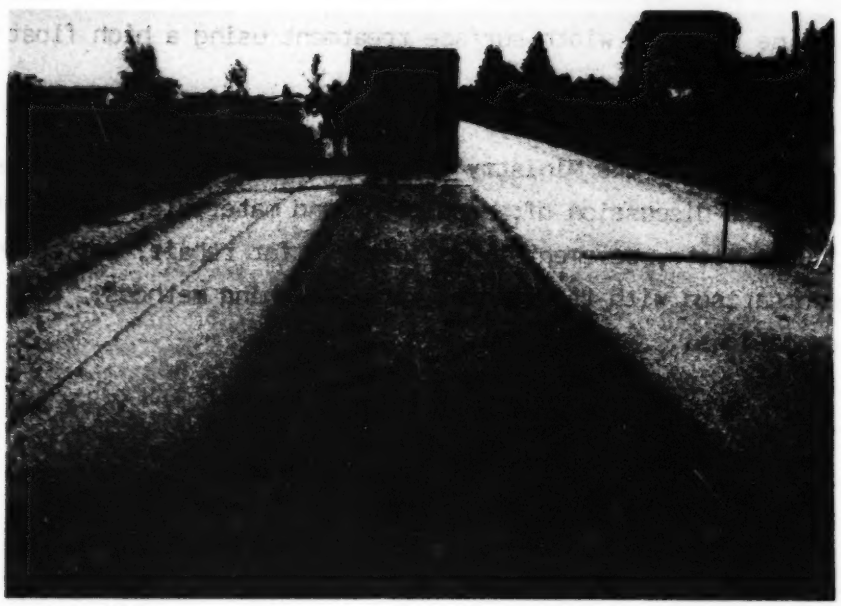

Figure 2 : Hwy. 46 After Repair

2.0 DYNAPAC PAVEMENT PATCHER

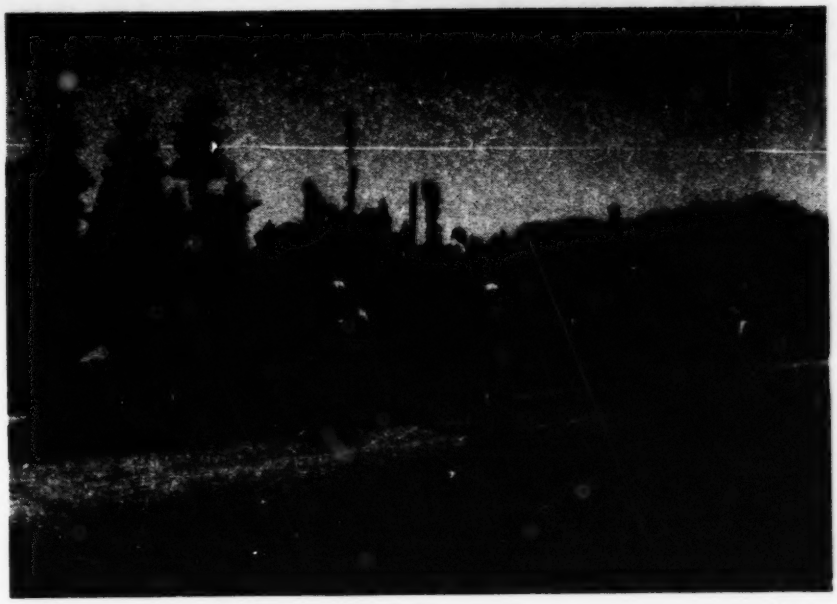

Figure 3 : Dynapac Pavement Patcher

i) General Description

The Dynapac Pavement Patcher contains an onboard computerized control system, a binder pump, an adjustable spray bar, a self-loading aggregate hopper and three static roller drums. The machine has a working speed of 3-4 km/h and is capable of being towed at up to 30 km/h on its pneumatic-tired travel wheels.

The machine has a working width of 2.1 m and seven individual control levers allow the operator to spray any width from 0.3 m to 2.1 m in 0.3 m intervals. Any spray pattern within this range can be acheived including multiple parallel patches. Technical specifications are shown in Appendix A. Figure 4 is an example of the selective patching capabilities of this machine.

Figure 4 : Selective Patching

ii) Operation

The alignment pins in front of the unit are a guide to the operator. When the pins are above the surface to be patched, the operator activates the appropriate control lever(s) (Figure 5) depending on the width of repair required. The operator deactivates the control lever(s) when the alignment pins pass the area to be repaired.

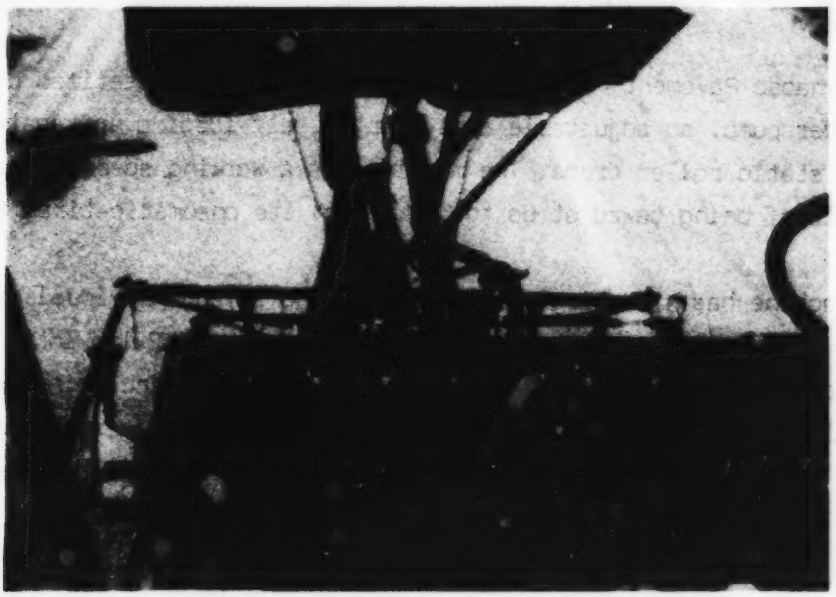

Figure 5 : Control Levers and Operator's View

The unit has a fully circulating spray bar with seven individual spray nozzles. The emulsion is sprayed in a fan shaped pattern and adjacent sprays are offset to each other to achieve uniform coverage. The emulsion application rate is controlled by the computer and can be adjusted from 0.6-2.2 kg/m^2 in .1 kg/m^2 increments.

The aggregate is spread onto the binder from seven individual gates. The aggregate rate can be adjusted manually from 0-50 kg/m^2 by means of 11 gate settings.After the aggregate has been spread it is compacted by the three static roller drums built into the machine.

The computerized control system synchronizes the control levers, spray nozzles and aggregate gates to ensure that only the area designated by the operator will be covered. The computer delays the application of the binder relative to the forward speed of the unit. The computer also monitors the number of nozzles in operation and regulates the binder pump speed to achieve the set application rate.The opening/closing of the aggregate gates is controlled to obtain correct coverage of the binder.

3.0 TEST SITES

Table 1 summarizes the location, pavement type and pavement defects of the trial sections. Location maps are shown in Appendix B and Figure 6.

District	Highway	Pavement Type	Pavement Defects
Port Hope	Hwy. 46 Argyle to Bolsover	- hot mix -15+ yrs. old - AADT 1600 - SADT 2800	-sections of braided/ alligator cracking
Bancroft	Hwy. 28 Bancroft Easterly	- surface treated primed gravel - age unknown - AADT 700 -SADT 950	- pavement edge breakup - alligator cracking
Huntsville	Hwy. 60 Oxtongue River to Algonquin W. Gate	- recycled hot mix - 5 yrs. old - AADT 1400 - SADT 2500	- segregated areas - edge and C.L. cracking
	Hwy. 117 9.0 km W. of Hwy. 35 Westerly	- hot mix - 6 yrs. old - AADT 800 - SADT 1600	- longitudinal and alligator cracking
	Hwy. 520 Burks Falls Westerly	- surface treated primed gravel - age unknown - AADT 900 - SADT 1400	- pavement edge breakup - assorted cracking and wheeltrack rutting

Table 1 : Site Description

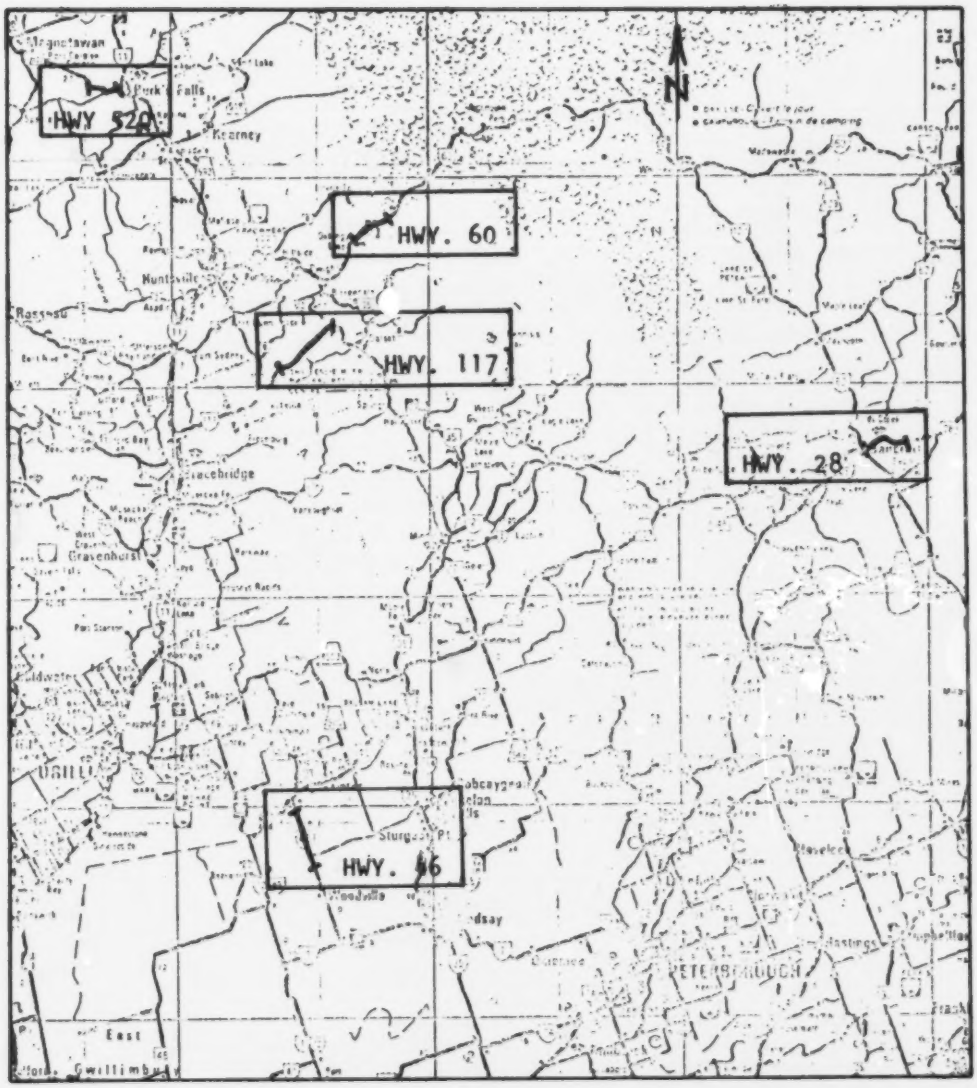

Figure 6 : Trial Location

4.0 CONSTRUCTION

4.1 Equipment

The equipment complement was as follows:

- 1 Dynapac Pavement Patcher HR-21 (rented)*
- 1 6-ton tandem axle dump truck with 4500 L emulsion tank (rented)*
- 2 3/4-ton crew cabs (MTC)*
- 1 loader (MTC)*

- 2 to 4 5-ton single axle dump trucks (MTC) or 2 tandem axle dump trucks (rented)
- 1 5400 L distribution truck (MTC)
- 1 power broom (MTC)
- 1 rubber-tired roller (MTC)
- 1 sign truck (MTC)

* common to all Districts

4.2 Personnel

The personnel complement was as follows:

- 2 operators for the Dynapac Spray Patcher*
- 1 foreman*
- 2 flagmen*
- 2 to 4 truck drivers*
- 1 roller operator (if used)
- 1 broom operator (if used)
- 1 distributor operator (if used)
- 1 sign truck driver (if used)

* common to all Districts

Note: - broom not in continuous use.
- aggregate drivers load their own trucks.

4.3 Preparation of Surface

Surface preparation work was minimal. Sweeping with a power broom occurred on Hwy. 28 and Hwy. 520 to remove excess dirt and gravel from the edge of pavement. On Hwy. 46 the distressed areas were marked out (start, end and width) with spray paint prior to patching.

Large cracks (greater than 25 mm) and holes were not filled before patching and therefore the effectiveness of the repair was minimized.

4.4 Construction Procedure

i) Set-Up

Prior to the start of the daily patching, the following operations were carried out at the job site:

- The emulsion was heated, if necessary, to the correct spraying temperature (60-80 C).
- The supply tank was filled by the distributor or tanker.
- The intake and return lines were connected.
- The units diesel engine and compressor were started.
- The nozzle setting, spray bar height and aggregate quantity settings were adjusted, if necessary.
- The transport wheels were raised and locked in position.
- The alignment guide bar was lowered and positioned.
- The bitumen circulation pump was started and checked.
- The binder application rate was set on the computer and the daily total figures were returned to zero.

ii) Operation

Tandem or single axle dump trucks unload into the 1 m^3 receiving hopper(Figure 7). The unit must be stationary to reload the hopper. Belts from the receiving hopper fill the unit's spread hopper (capacity 4.5 m^3).

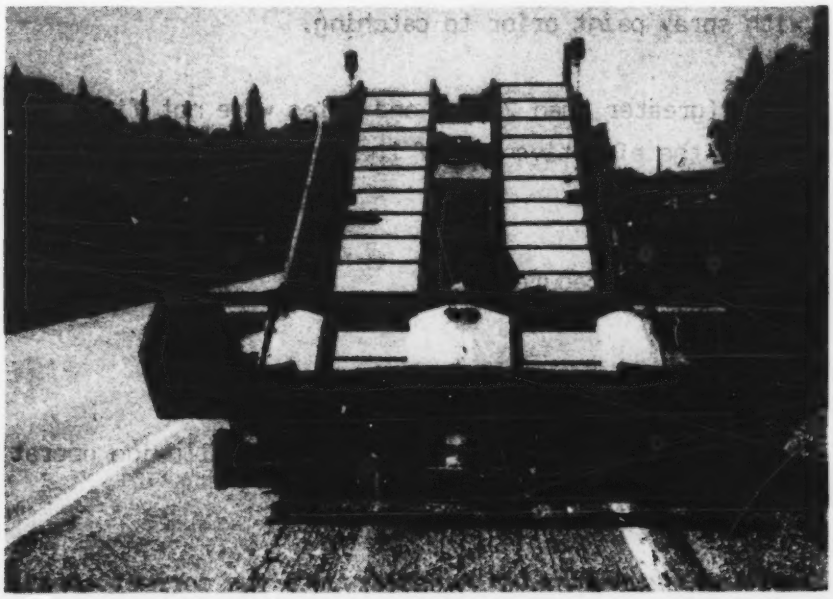

Figure 7 : Rear Hopper

The driver of the towing vehicle is then given the signal to proceed at 3.0 km/h. The computer closes all nozzles and gates when the speed goes below 0.5 km/h and resumes when operations continue.

After the day's operation was complete, the machine had to be cleaned. Cleaning consisted of: pumping the lines clean, scrubbing the spray nozzles, scrubbing the strainer, cleaning the unit, and flushing lines, pumps and spray bar with diesel fuel. This procedure took approximately 1 h.

iii) Traffic Control

Signs were placed in accordance with the Traffic Control Manual and included Men at Work and Obey Flagman signs. Large Surface Treatment signs were placed

at the limits of work and 50 km/h signs were spaced in appropriate locations as work progressed.

Flagmen directed traffic to one side in the immediate vicinity of the unit, otherwise traffic was not disrupted. In the Huntsville District a 5-ton truck equipped with a flashing arrow trailed the operation and helped direct traffic (Figure 8).

Figure 8 : Sign Truck

4.5 Materials

i) Binder

CRS-2 emulsified asphalt was selected as the most suitable binder due to its fast curing and bonding properties. Fast curing is necessary to prevent aggregate loss under immediate traffic. The CRS-2 was obtained from Norjohn Ltd., Burlington, Ontario.

The emulsion delivery temperature tended to be low (60^{o} C) and could not be used for more than one day without additional heating. The emulsion appeared to perform better (faster set-up) when it was heated close to the upper limit of the specification (80^{o} C) . The higher temperature also reduced the strain on the unit's pumping and circulation systems.

Weather conditions proved to have a significant impact on the performance of the binder. The majority of material (all but Hwy 60) was placed in warm favourable conditions and binder set-up was rapid. On Hwy. 60 , however , temperatures were low (10-15^{o} C) and the weather was wet. The set-up time was delayed considerably and aggregate loss under traffic resulted.

Laboratory test results (Appendix C) show that all samples had relatively low viscosity with three being below specifications (OPSS 1103). One tanker load was sent back based on rejectable viscosity results and poor road performance (June 12/85). One sample failed the sieve test but all other requirements were met.

ii) Aggregate

Class 1 aggregates (OPSS 304.05) typical for a single surface treatment were obtained locally. Aggregate came from two sources: Pinewood Aggregates - Peterborough and Hutcheson's Pit - Huntsville. The material from Peterborough was a limestone chip and was used on Hwys. 46 and 28. Crushed granite chips from Hutcheson's Pit were used on the other highways.

The gradation of the aggregate used is shown in Appendix D . The aggregate used on Hwy's 46 and 28 had a finer gradation and tended to give a better visual appearance and a more uniform patch.

In addition to the two main types of aggregate, two loads of 4.75 mm. limestone chips were used on Hwy 117 and two loads of crusher run gravel were used on Hwy 520.

iii) Application Rates

Standard single surface treatment application rates were initially chosen with the idea of modifying them according to the resulting appearance and performance. These rates are 1.65-1.9 kg/m^2 for the emulsion and 12.0-14.0 kg/m^2 for the aggregate.

The initial binder application rate of 1.8 kg/m^2 proved to be appropriate and further adjustments were not necessary for most of the project. It was increased to 1.9 kg/m^2 on Hwy. 60 in an attempt to combat aggregate loss.

After several trials, gate setting 6 was chosen in Port Hope and also Bancroft (aggregate from same source for both) which resulted in a rate of 19.8 kg/m^2. Aggregate application was reduced, based on visual appearance, in Huntsville District to approx. 16.3 kg/m^2 (gate setting 5) due to the different source of aggregate.

5.0 PRODUCTION

Table 2 is a daily summary of production and costs. The average productivity for the entire project was 850 m^2/hr when operational. This figure was obtained by dividing the area patched (97 400 m^2) by the hours of operation (114.75). The hours of operation include start-up, spraying and clean-up.

On Hwy 46 only 5.75 h were actually worked over four days due to rain and off specification binder (less than 60°C). In Huntsville, on Hwy 60, operations were halted or cancelled entirely on five days due to rain and one day due to the low viscosity of the binder.For the remainder of the work, delays and standby time were minimal.

The standby time due to failure of the Dynapac equipment was only 8 hours in total for the whole project. Floating the unit to a new location took the major part of a day due to the distances involved.

PRODUCTION						
Location	Date	m^2	* Hrs	m^2/hr	Cost ($)	Comments
Port Hope Hwy 46	May 27	-	0	-	1855	Rain
	28	1806	1.75	1032	4168	Pump plugged
	29	-	0	-	1463	Binder < 60 ^{0} C
	30	2616	4	654	4717	Rain Halted Work
	May 31	-	0	-	1457	Floated to Bancroft
Bancroft Hwy 28	June 3	4807	4.5	1068	5837	Oil Arrived Late
	4	9822	11.5	854	10869	Work Went Well
	5	7533	8.5	886	8303	2 Hrs. Standby-rain
	6	12510	12	1042	12589	Work Went Well
	7	5967	5.5	1084	7524	2 Hrs. Standby-repair
Huntsville Hwy 60	10	-	0	-	2024	Floated to Hwy 60
	11	4130	7.5	550	6067	Viscosity low
	12	-	0	-	1768	Sent CRS-2 Back
	13	750	3	250	2433	Rain
	14	4295	8	537	5588	Work went Well
	17	4164	9	462	5677	Rain Halted Work
	18	-	0	-	1692	Rain
	19	-	0	-	1079	Rain
	20	2440	6	406	3900	Rain Halted Work
	21	4106	4.5	912	4534	Ran out of Binder
Hwy 117	24	4345	4	1086	5416	Moved to Hwy 117
	25	7416	6	1236	8670	3 Hr. Standby- repair
	26	4251	5	850	6484	Floated to Hwy 520
Hwy 520	27	4806	4	1201	5746	4 Hr. Standby-Signs
	June 28	4923	5	985	5678	Quit Early
	July 2	6713	5	1342	7749	3 Hr. Standby-Battery
		97400 m^2	114.75 Hrs			

*Hrs -includes time of start up, spraying, and clean up

Table 2 : Production

6.0 COSTS

Table 3 summarizes the total costs associated with this demonstration project.

Location	Accomplishment (m^2)	Total Cost ($)	Cost/m^2 ($/$m^2$)
Initial Modifications	–	5120	–
Port Hope Hwy 46	4422	13500	3.05
Bancroft Hwy 28	19885	34750	1.14
Huntsville			
Hwy 60	40639	46500	1.75
Hwy 117	16012	20575	1.28
Hwy 520	16442	19175	1.17
TOTALS	97 400 m^2	$139 620	AVG.=$1.43

TABLE 3 COST SUMMARY

The total cost of the project was $ 139 620 for 97 400 square metres of patching. This gives an average cost per square metre of $ 1.43 which compares favourably to the original estimate of $1.50/$m^2$.

The cost per square meter was substantially higher in Port Hope District due to equipment difficulty, weather and below specification temperature of the binder. The cost was also high on Hwy. 60 mainly due to rain delays.

Costs for Hwy. 28, Hwy. 117 and Hwy. 520 are all similiar and represent favourable conditions.

Table 4 gives the cost breakdown of the project.

Location	Equipment Cost ($)	Material Cost ($)	Wages & Expenses ($)	Total Cost ($)
Initial Modifications	2723	-	2397	5120
Port Hope	5231	4415	3755	13500
Bancroft	11935	26440	8125	46500
Huntsville	23134	31115	20251	74500
Total Cost	43023	61970	34528	$139620
% of Total	30.8	44.5	24.7	

TABLE 4 COST BREAKDOWN

The cost breakdown shows that the material costs (44.5% of the total cost) were the most significant. The material unit costs were essentially the same for all districts. The costs for MTC vehicles and equipment were calculated based on standard MTC hourly rates. The Dynapac unit was rented from Dynapac Ltd. by the MTC at $400 per day. Further cost breakdowns can be found in Appendix E.

7.0 Full Width Surface Treatment

i) Background

A trial was conducted on July 4 , 1985 to examine the feasibility of using the Pavement Patcher for full width surface treatment. It took place on Hwy. 534 from Restoule northerly.

The binder used was an HF-150S high float asphalt emulsion applied at a rate of 1.4 kg/m^2. The aggregate was stockpiled granular M material containing some oversize material (12% was greater than 16 mm).

ii) Operations

Some stone/sand segregation occurred and occasional blockage of the aggregate gate openings. The blockages were caused by oversize stone (up to 150 mm) becoming stuck in the gates. Isolated areas of existing surface treatment cracked and distorted under the rollers.

A total of 10 220 m^2 was treated in approximately 5h. Two of the necessary three passes were completed on a 1.6 km section.

iii) Comments

The overall quality of the treatment was satisfactory and most of the difficulties encountered were the result of the poor quality of the aggregate used.Following the completion of the day's work it was decided to discontinue operations. Traditional surface treatment equipment was already on site and could do the work faster and cheaper than the Dynapac unit. The main difference in speed and therefore cost was due to the traditional equipment's ability to treat the full width in only two passes versus three for the Pavement Patcher.

8.0 Comparison With Manual Spray Patching

A direct comparison can be made between traditional spray patching and patching using the Pavement Patcher. They both achieve a similiar type of repair and use the same materials.

In traditional spray patching a hand spray bar is used to apply the binder and aggregate is spread with shovels. The result is an erratic shaped patch with inconsistant material application rates. The Pavement Patcher applies both binder and aggregate at the desired uniform rate in a consistent and neat patch pattern and then compacts it. The quality and durability of this type of patch should be far superior.

The Dynapac unit has production rates conservatively estimated at approximately 10 times those of manual spray patching. The cost of manual spray patching is approximately 10%-50% higher than the cost of mechanized patching (average of $\$1.43/m^2$).

9.0 Performance Evaluation

A patch survay was undertaken on September 19'th and 20'th, 1985, approximately three months after construction. The purpose of the survey was to examine the condition of the patches and to obtain close-up photographs for comparison with later photographs, to determine the amount of stone loss over the winter season.

9.1 Initial Patch Survey

HWY 46

- -Good retention of stone
- -Binder level has risen to approximately 30-50% the height of the stone (from 25-30% at time of construction)
- -Large cracks under the patches noticeable as depressions
- -No flushing exhibited

HWY 28

-Good retention of stone
-Binder level approximately 50%
-Patch edges are relatively smooth - provide decent ride
-No flushing exhibited
-Crack reflection not evident

HWY 60

-In some areas substantial loss of stone in wheel tracks
-Good retention of stone in other areas
-Binder level approximately 40%
-No flushing exhibited
-Crack reflection not evident
-In one isolated area there are black streaks across the road caused by very heavy rain at time of construction

HWY 117

-Good retention of stone
-Binder level 30-50%
-Crack reflection not evident
-In area of limestone chips (one truck load) the binder level is high (approx. 70%) and could flush in the future

Hwy 520

-Good retention of stone
-Binder level 30-50%
-No flushing exhibited
-Crack reflection not evident
-In the area of wheeltrack rut treatment the binder level is approx. 70% and could flush in the future
-Some stone at the edge of the patches has kneaded into the existing surface and the ride is very good

10.0 Conclusions

1) The Pavement Patcher is a viable tool for repair of pavement defects, such as segregation, centreline, edge and alligator cracking.

2) Construction posed no significant difficulties.

3) The unit has many advantages over hand spray patching including decreased costs and increased production

4) The initial performance of the patches is good.

5) The average cost per square metre of patch using the Dynapac Pavement Patcher was $1.43.

6) The average production when operating was 850 m^2/h.

7) Cold, wet weather during construction had a detrimental effect on stone retention.

8) Wheeltrack rutting repair was not attempted to a major degree but initial results look favourable.

11.0 RECOMMENDATIONS

Monitoring of patch performance should continue. Comparison of a spring patch survey with the initial survey will reveal the performance of the patches over the winter and the damage caused by the snowplows. Patches should also be checked in the summer for evidence of flushing. This monitoring should give an indication of the quality of the work and an idea of the expected life of these types of patches.

Premarking of areas to be repaired should be considered. It reduces the pressure on the operator, decreases wastage and improves the aesthetics of the finished product. For wheeltrack rutting to be corrected, premarking must be done since the operator cannot identify areas of rutting from above.

If further work is to be done using this type of machine, consideration should be given to making modifications as follows;

- -the recieving hopper could be modified to increase capacity and to allow for truck hook-up and continuous loading.
- -the spread hopper should be equipped with directional vanes.
- -the spray bar mounting should allow movement for easier cleaning and maintenance.
- -the operator's view of the spread hoppper should be improved (possibly use of a mirror).

APPENDIX A

TECHNICAL SPECIFICATIONS : DYNAPAC HR-21

Shipping length	7.65 m
Total width	2.50 m
Total height	2.90 m
Patch width available	0.3 - 2.1 m
Weight, empty spread hopper	9650 kg
Weight, full spread hopper	16500 kg
Capacity of spread hopper	4.5 m^3
Static linear load, empty spread hopper	27 kg/cm
Static linear load, full spread hopper	53 kg/cm
Maximum transport speed with empty spread hopper, wheels down	30 km/h
Binder application rate	0.6 - 2.2 kg/m^2
at working speed of	2.0 - 8.0 km/h
Aggregate application rate	0.0 - 50 kg/m^2

APPENDIX B

SITE LOCATIONS

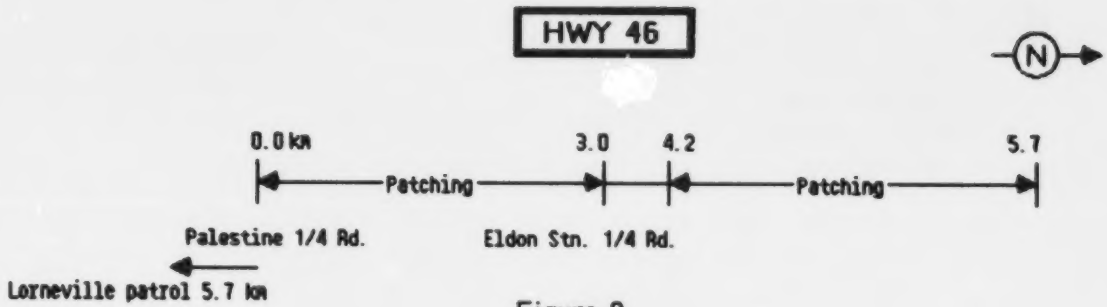

Figure 9

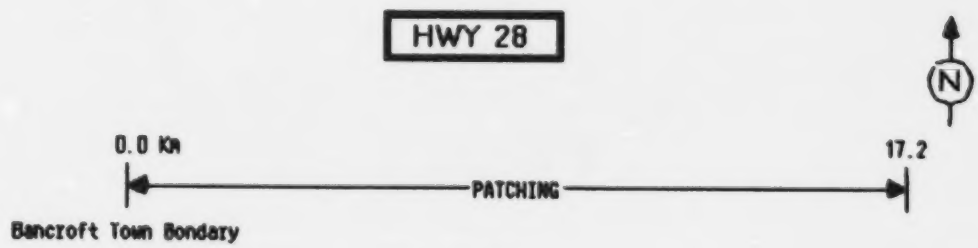

Figure 10

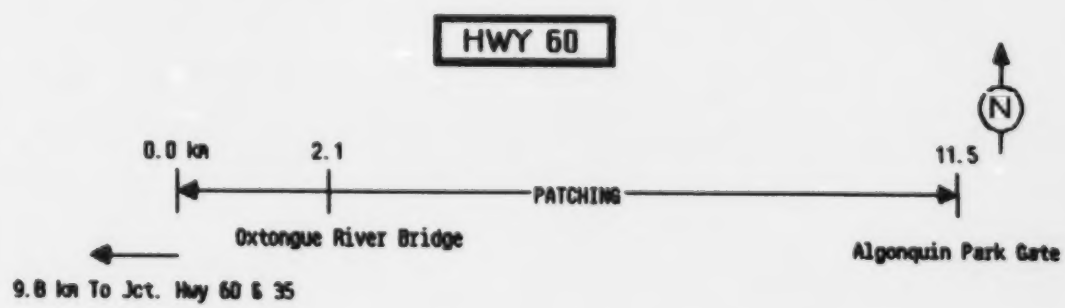

Figure 11

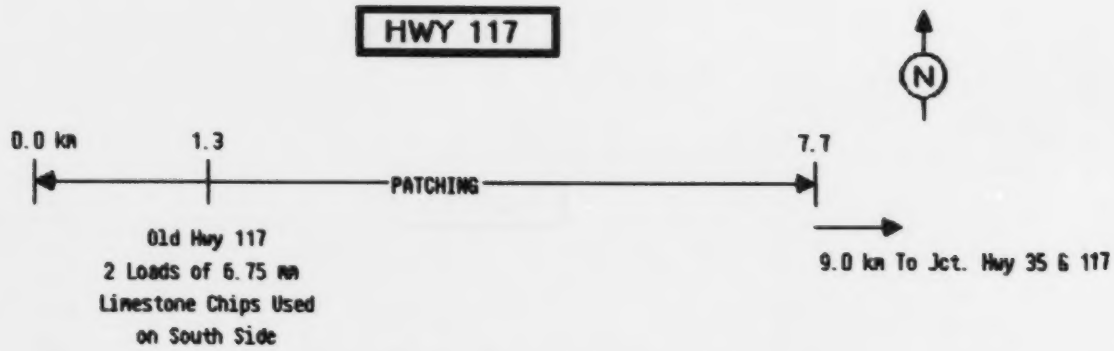

Figure 12

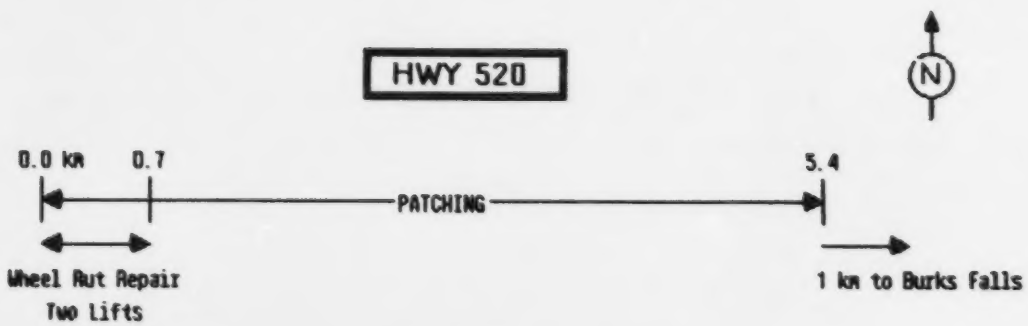

Figure 13

APPENDIX C

COMMENTS

i) Initial Set-up and Modifications

A six-ton tandem dump truck was rented to serve as the emulsion supply and towing vehicle. A 4500 L insulated asphalt tank was installed on the truck (Figure 9) using 100 x 100 mm timbers and a section of channel iron to keep it in position.

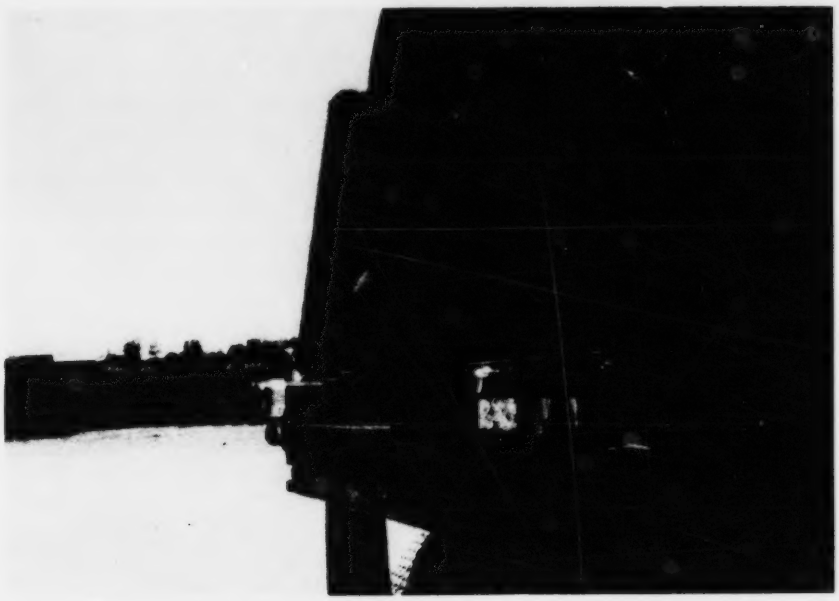

Figure 9 : Rear View of Supply Truck

Upon arrival of the Dynapac unit several modifications were necessary adapting the unit to our equipment. Dynapac field personnel were on site to make the adjustments which were as follows:

- A emulsion return line from the Dynapac unit was placed through the top cap of the tank.
- Quick disconnect fittings were installed on the suction and return lines.
- A pintle hook ring was welded onto the tow bar.
- The receiving hoppers roller assembly was shortened to allow tandems to dump without spillage.

A trial run revealed a blockage in the unit's emulsion pump. The pump and spray nozzles were disassembled and cleaned. The second trial run was successful and the Dynapac personnel felt the blockage was due to poor cleaning of the unit previously and/or waste material left in the supply tank.

ii) COMMENTS ON CONSTRUCTION PROCEDURE

A) Port Hope

In Port Hope District the emulsion transport tanker stayed on site. The emulsion supply truck was filled directly from the tanker. The tanker did not have heating capacity and after one night the emulsion temperature was below the specification temperature and could not be used.

Two hired tandems were used to haul aggregate from the stockpile. The large capacity of the tandems could not be fully utilized since the unit had to be stationary to load.

Spray paint was used to mark out the areas to be repaired and proved to be helpful.

B) Bancroft

In Bancroft District the emulsion tanker discharged into a heated storage tank situated at the local MTC patrol yard. The emulsion was kept at spraying temperature and the District's distributer was used to transport the emulsion to the job site.

A power broom (MTC) was used to clean the pavement edge prior to repair.Three MTC 5-ton trucks were used to haul the aggregate and had no difficulty unloading. A rubber-tired roller (MTC) was used for further compaction since the pavement was distorted and the steel rollers were not giving uniform compaction.

C) Huntsville

A storage tank and distributer were also used in Huntsville District. The storage tank, however, was not heated and the emulsion had to be heated by the distributer truck. Heating every morning caused delays up to 1.5 hours. Two to four MTC 5-ton trucks were used for aggregate hauling and a sign truck was used to assist in traffic control. A power broom (MTC) was used on Hwy. 520 to clean the pavement edge.

D) General

When the work was stopped for less than 1 hour the emulsion was kept circulating and no problems resulted. Longer stoppages necessitated that the pump and spray bar be cleaned to prevent blockages.

At the end of the day's work no emulsion could be left in the tank and therefore work proceeded until the emulsion ran out. Lack of proper gauges on the supply tank made it difficult to accurately judge the amount of emulsion left. This meant that aggregate trucks must continue to reload and proceed to the job site, only to return and unload if they weren't needed. The spread hopper had to be empty in order to move the unit on its rubber-tired transport wheels. Partial loads of aggregate had to be wasted when the emulsion ran out.

Turning and parking the unit was not difficult needing only a standard size driveway. The operator assisted the driver by means of the unit's steering wheel.

EQUIPMENT

a) Dynapac Unit

- The receiving hopper was not very acceptable nor was the method of loading. The hopper overflowed easily and tandems with their short overhang had

difficulty dumping. Loading had to proceed when the unit had stopped because of a lack of a truck hook-up method to the unit.

- The hydraulic auger in the spreading hopper was working but was ineffectual since directional vanes were not in place. The vanes are available and enable the operator to transfer material to either side of the hopper as needed.

- On distorted surfaces the edge of the steel rollers rode on the high spots marring the surface and picking up emulsion and aggregate.

- The spray bar was difficult to clean.

- The operator could not see into the spread hopper without leaving his position.

- The compaction was not uniform - much greater when the spread hopper was full (16500 kg) than when empty (9650 kg).

b) Other Equipment

- The rubber-tired rollers used in Bancroft proved to be worthwhile on distorted pavement. The unit's steel rollers tended to ride on the high points and not compact the low spots. The rubber-tired roller ensured compaction of the entire patch.

- The 5-ton sign truck used in Huntsville District (Figure 8) was found to be effective as a traffic control tool. It increased driver awareness and indicated to which side traffic was to pass (the spray patcher was sometimes going down centre line).

- The tandem trucks used had some difficulty dumping but not excessively so. The use of large capacity tandems would have produced a more efficient operation if loading on the go had been possible. Up to four 5-ton trucks (capacity approx. 7 tons) were necessary to keep pace when the round trip time to the stockpile exceeded half an hour.

- The rotary power brooms used in Bancroft and on Hwy. 28 did an adequate and quick job cleaning the surface prior to treatment.

APPENDIX D

Table 5 : Aggregate Gradations

MTC Sieve Designation	% Passing		
	Class 1 Requirements	Huntsville	Port Hope & Bancroft
13.2 mm	100	99.5	100
9.5 mm	75–100	87.7	99.3
6.7 mm	0–40	32.5 *	58.2 *
4.75 mm	0–10	0	6.2
75 um	0–1	0	0.5

* Note large difference –
Aggregate Used in Huntsville is much coarser

Table 6 : Emulsion Test Results

TEST	RESULTS						OPSS Specification 1103
Viscosity 50% SFS	137.6	80.7	93.9	92.2	122	*	100–400
Residue % by Dist.	67.4	67.7	6801	68.2	68.4	68.9	67+
Residue–Pen. @ 25 °C	127	171	133	129	119	120	100–250
Residue –Ductility	60+	60+	60+	60+	60+	60+	60+
Settlement % 5 days	2.15	1.15	1.3	0.9	1.6	*	0–5
Sieve Test	0.035	0.098	0.01	1.02	0.063	*	0–0.1
Demulsibility %	57.4	43.7	40.7	93.8	100	57.2	40+
Charge	+	+	+	+	+	+	+
Oil Portion %	1.0	0.5	0.5	0.5	0.5	*	0–3

— Does not meet specifications

* Results not available

APPENDIX E

Table 7 : Detailed Cost Breakdown

Item	Modifications ($)	Port Hope ($)	Bancroft ($)	Huntsville ($)	Total ($)	% of Total (%)
Equipment						
Tanden Truck	1846	1195	1904	4135	9080	6.5
Tank	550	200	250	800	1800	1.3
Dynapac	1600	-	2000	6400	10000	7.2
Crew Cabs *	252	168	176	675	1271	0.9
Single Axles *	-	-	3393	4485	7880	5.6
Rented Tandems	-	1917	-	-	1917	1.4
Light Truck *	-	-	-	1441	1441	1.0
Distributer *	-	-	1155	2591	3750	2.7
Loader *	-	159	440	680	1280	0.9
Broom *	-	-	214	288	500	0.4
Roller *	-	-	645	-	645	0.5
Diesel Fuel	-	100	302	670	1070	0.8
Oil And Parts	75	-	-	16	91	0.1
Float Cost *	-	-	1457	779	2236	1.6
Materials						
CRS-II	-	3504	18196	23540	45140	32.3
AGGREGATE	-	1010	8244	7575	16830	12.1
Wages & Expenses						
Wages	1768	3084	7608	16956	29416	21.1
Expenses	629	671	517	3295	5112	3.7

* MTC Equipment